

Superconductivity, as orderly as it gets (from cuprates to gravity).

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Is there anything missing from our basic understanding of the phenomenon called superconductivity? Having presented it for many years in class as a closed subject, I was surprised myself when we found out that there is still something to be learned. This requires rather modern field-theoretic technology. The conventional theory revolves around the gaseous limit, i.e. a dilute system of weakly interacting particles (BCS, Bogoliubov). How to think about the opposite limit, the superconductor being as close to solidification as possible? This limit turns out to be tractable in terms of a theory called 'duality in 2+1D quantum elasticity', which has much to do with the idea of quantum liquid crystals introduced by Kivelson and coworkers. The field theory generates an interesting, warped view on what it all is about, as well as a number of precise predictions: screening current oscillations and new 'dual Higgs modes', in principle measurable in the electrodynamical response (requiring however costly new machines). Last but not least, in the relativistic generalization of this affair one can discern states of matter which are in fact at long distances indistinguishable from the space-time envisaged by Einstein in his theory of general relativity. Whatever it means, this 'emergent gravity' turns out to be a most effective way to enrage relativists of any kind.